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The cognitive specificity of associative responses in patients with chronic pain

John D. McKellar[1,3*], Michael E. Clark[2,3] and Jan Shriner[4]

[1]VAHSR&D Center for Health Care Evaluation, VA Palo Alto Health Care System, Palo Alto, USA
[2]James A. Haley Veterans Affairs Hospital, Chronic Pain Rehabilitation Program, USA
[3]University of South Florida, Tampa, USA
[4]VA Palo Alto Health Care System, Palo Alto, USA

Objective. Previous studies have found evidence of an associative response bias for patients with chronic pain. This body of research is not clear, however, on whether this bias is specific to patients with chronic pain, or whether the bias is specific to pain stimuli or illness/disability stimuli.

Design. This is a cross-sectional study involving the comparison of selected groups (chronic pain, acute pain, and medical-staff controls).

Method. This study included 80 male participants with chronic pain, 50 male participants with acute pain, and 49 male participants who served as medical staff controls. All participants completed the Beck Depression Inventory, the State-Trait Anxiety Inventory, a pain intensity VAS, and the single-word associate homographic response task.

Results. Evidence was found for the specificity of pain responses to homographic pain stimuli as the chronic pain group produced more of these responses than the two comparison groups.

Conclusions. These findings were seen as providing evidence for an associative response bias. This bias appears specific to pain-related stimuli and reflects the cumulative effects of pain over a period of time.

* *Requests for reprints should be addressed to John McKellar, Center for Health Care Evaluation, VA Palo Alto Health Care System, Menlo Park Division, (152), 795 Willow Road, Menlo Park, CA 94025, USA (e-mail: mckellarjd@yahoo.com).*

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Despite the reported success of multidisciplinary programmes relative to unimodal treatments or controls, there remains a significant portion of participants who do not achieve significant gains (40–60%) and others who fail to maintain progress achieved during treatment (Turk, 1990). This variability in response has led researchers to investigate factors that might account for these differences. One way to categorize factors that might influence treatment is in terms of patient characteristics and process variables. Patient characteristics are pre-treatment variables that are thought to facilitate or hinder treatment outcome. Process variables are thought to explain the mechanisms of treatment. Cognitive biases represent one class of pre-treatment variables that has been investigated in patients with chronic pain. These variables are not seen as inherent to all patients with chronic pain but instead are viewed as factors that may contribute to disability for some patients. This approach to the study of individual differences within chronic pain patients has borrowed from research in the areas of depression and anxiety in an attempt to investigate potential cognitive mechanisms involved with chronic pain.

Information processing approaches to psychopathology

Information processing approaches to psychopathology stipulate that faulty processing of information contributes to the onset and maintenance of psychological dysfunction. Individuals suffering from negative affective states are thought to display functional cognitive mechanisms and operations that structure information processing in a maladaptive fashion (McKellar, Malcarne, & Ingram, 1996). Because of the quality and quantity of information an individual attends to at one time, people must be selective in what they learn, remember or infer in a given situation (Neisser, 1967). Mineka and Gilboa (1998) outline three primary areas covered by research investigating information processing biases in psychopathology: attention biases, memory biases and interpretation biases.

The success of information processing paradigms in research with affective disorders has led to a borrowing of such techniques by chronic pain researchers. Several studies suggest that chronic pain patients evidence memory biases. Measurement of memory biases typically include explicit memory tasks, where participants are told to remember and then later recall information, as well as implicit memory tests such as the incidental recall task. Some studies have found that chronic pain patients exhibit a bias towards pain-related stimuli (Edwards, Pearce, Collett, & Pugh, 1992; S. A. Pearce *et al.*, 1990). Other studies have found that this bias is greater for stimuli encoded with references to themselves, rather than in reference to others (Pincus, Pearce, McClelland, & Isenberg, 1995; Pincus, Pearce, McClelland, & Turner-Stokes, 1993). Calfas, Ingram, and Kaplan (1997) found that depressed osteoarthritis patients tested in an incidental recall task displayed a bias in recall of state-depressive words. All of the above studies found the recall bias to be related to levels of depression.

The evidence for attention bias in patients with chronic pain is less clear. J. Pearce and Morley (1989) is the only study to find evidence for an attention bias for pain patients on a Stroop task using pain intensity stimuli. Subsequent attempts to replicate the above findings have not proven successful (see Pincus, Fraser, & Pearce (1998) for a review of unpublished studies). It has been noted that the initial findings of J. Pearce and Morley (1989) may have been owing to differences in the level of anxiety in the experimental and control groups (Pincus, Pearce, & Perrott, 1996). This interpretation is consistent with studies that have linked the Stroop task to elevated levels of anxiety (see Mathews, 1997, for a review).

Two studies (Pincus, Pearce, McClelland, Farley, & Vogel, 1994; Pincus *et al.*, 1996) support the notion that chronic pain patients may show interpretive biases towards negative health- and pain-related stimuli. This area of research is particularly promising in that the results appear, at this point, to be independent of a chronic pain patient's level of depression and anxiety. In one study (Pincus *et al.*, 1996), chronic pain patients were asked to supply first word associate responses to negative health-related ambiguous homophones (i.e. dye, die). The authors found that chronic pain patients were more likely to impose a negative health-related interpretation on the ambiguous homophones than were control patients (college students). Anxiety and depression did not correlate significantly with the number of illness-related interpretations, although the number of interpretations did account for 25% of the variance in current pain intensity. In a second study, Pincus *et al.* (1994) used homographs instead of homophones in an attempt to measure interpretation bias in patients with chronic pain. Homographs are words with one or more meanings. For example, the word 'back' could refer to a part of the body or to the relative position of something. In order to control for frequency of usage of medical terms or pain terminology, a second control group (osteopaths and physiotherapists) was added to the study. They found that pain patients were more likely to respond with pain associations to ambiguous cues than either group of control participants (college students or osteopaths and physiotherapists).

The above studies on interpretation biases, however, leave several questions unanswered. The first relates to whether the effects noted in these studies are specific to chronic pain, or whether they merely reflect the state of being in pain. Is the interpretation bias indicative of well-developed associative networks or schemas related to chronic pain or illness, or are such individuals just more likely to be drawn towards a pain or illness interpretation of stimuli because they are currently experiencing pain? Another important question involves the experimental stimuli used in previous experiments and the manner in which they were coded. Unfortunately, the number of pain sensory and illness stimuli in both of the studies (Pincus *et al.*, 1994, 1996) was insufficient to separate out any effects that may have been specific to each of the cues.

The current study attempted to extend previous research related to information processing in patients with chronic pain (Pincus *et al.*, 1994, 1996). In order to determine whether interpretation biases (response biases) are specific to chronic pain and not to the state of being in pain, this study included an acute pain control group in addition to the chronic pain and standard (no-chronic pain) control groups utilized in previous studies. Similar to the Pincus *et al.* (1996) study, a medical-staff control group was used to control for the effects of frequency of usage of health-related terms since medical staff are exposed to such terminology on a daily basis. This study also used a sufficient number of pain intensity, disability and neutral stimuli to determine the content specificity of the bias effects. It was predicted that chronic pain participants would display the greatest interpretation bias. Furthermore, it was predicted that the bias would be specific to pain stimuli.

Method

Participants

Chronic pain patients were out-patients or in-patients who were recruited from an in-patient multidisciplinary pain programme at a south-eastern US Veterans Administration (VA) hospital. Acute pain patients were recruited from a post-surgical cardiothoracic unit at separate VA hospital in the western US (cardiothoracic post-operative patients were chosen because of indications from surgical nursing staff who reported that the pain level of these patients, in the immediate post-surgical period, averages around 5–6 on a 10-point scale). As data collection within a population of war veterans, all participants were male. No exclusions were made on the basis of mental disorder. Further demographic information on the groups is included in Table 1.

From a total of 90 eligible patients, 80 chronic pain patients were recruited for this study (enrolment rate of 88%; four additional patients were ineligible because of language barriers). From a total of 60 eligible patients, 50 acute pain patients were recruited (enrolment rate of 83%; five additional patients were deemed ineligible because of inadequate levels of pain). The 49 medical-staff control participants were recruited out of a total of 53 eligible participants who were approached for an enrolment rate of 92% (seven additional participants were ineligible because of reports of significant pain).

Procedures

The three groups of participants were recruited in person by the experimenter. Recruitment of participants with chronic pain occurred at the time of intake into an in-patient pain programme or immediately before or after a scheduled out-patient pain programme appointment. Chronic pain patients were over-sampled to ensure sufficient statistical power for multivariate analyses used in a different study. Recruitment of the 50 acute pain post-operative patients occurred no earlier than four days post-surgery. All acute pain patients were screened for a negative history of chronic pain and a current pain level of at least 3. The 49 medical-staff control participants were recruited because they did not report a history of chronic pain and did not report current pain (0 on VAS). After providing consent, all participants were administered the list of 120 stimulus words, the Beck Depression Inventory (BDI; Beck, Ward, Mendelson, Mock, & Erbaugh, 1961), the state form of the State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, & Lushene, 1970) and a 100mm PVAS.

Experimental stimuli

The stimuli consist of 120 common English words that were selected from the University of South Florida word associate norms (Nelson, McEvoy, & Schreiber, 1998). Of the 120 words, 40 were related to sensory pain, 40 were related to illness/disability, and the final 40 were neutral (judged to be unrelated to pain intensity or illness/disability). Embedded within each of the sets of 40 words are subsets of 30 words that are homographs (words with one or more meanings, i.e. back or fire). The 120 stimuli (see Appendix) were randomly ordered and typed on four separate sheets each containing 30 words. The order of the three sheets was randomized. Participants were instructed verbally to write the first word that comes to mind, related to the printed word, in the space provided. Participants were instructed to work as quickly as possible, to avoid using proper names, and to write only a single word in each space.

They were also told that there were no right or wrong answers, and that spelling was not important. Further details on construction of the word list are available from the authors.

Rating of words

The method of rating homographic stimuli was identical to that employed in previous homograph research (Nelson, McEvoy, Walling, & Wheeler, 1980; Stacy, Leigh, & Weingardt 1997). This method involves using two judges who independently rate the responses as being unambiguously related to pain, disability, or neither (neutral) and then resolve inconsistencies through mutual agreement. Also consistent with previous research, the same two judges were used to rate all words. Raters did not index the category of the stimulus words during the rating process, nor were they aware of which group the participant was in. For example, the word ‘tablet’ was given as a stimulus word that produced responses such as ‘pill’, ‘aspirin’ and ‘paper’. It was agreed between the two raters that ‘paper’ was a neutral response, ‘aspirin’ was a pain-related response because it related to analgesic medication, but ‘pill’ implied a disability/illness-related response because it was not referring specifically to pain medication. Initial inter-rater agreement was 91%, and after consultation consensus was reached on 100% of ratings.

Measures

Beck Depression Inventory (BDI)

The BDI is a 21-item self-report measure of depressive symptomatology (Beck, 1987). This instrument has been shown to have adequate reliability and validity (Beck, Steer, & Garbin, 1988). In this study, the suicide item was omitted to decrease the potential for the measure to cause distress. With the one item removed, the scores ranged from 0 to 63.

State-Trait Anxiety Inventory (STAI)

The STAI is a 40-item self-report measure of state (STAIS) and trait (STAIT) anxiety that possesses adequate reliability and validity (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983). For the purposes of this study only, the state version (STAIS) was utilized (scores range from 0 to 80).

Pain Visual Analog Scale (PVAS)

The PVAS consists of a 100mm horizontal line with two end-points labelled ‘no pain at all’ and ‘worst pain I can imagine’. Pain analogs have been found to serve as valid and reliable measures of the sensory-intensity dimension of pain perception (e.g. Duncan, Bushnell, & Lavigne, 1989). Scores on the PVAS range from 0 to 100 based on subsequent measurement with a ruler.

Medical and demographic variables

Data on duration of pain, percentage of income from disability, number of previous surgeries, age and education were obtained by self-report. Education level was assessed based on a 1–8 scale ranging from 1 = less than 6th grade to 8 = obtained graduate or professional degree.

Chronic pain screening
Screening for history of chronic pain was accomplished using structured questions that asked about the presence of chronic pain conditions in the last 5 years.

Results

Group differences in demographic and clinical variables
The three groups (chronic pain, acute pain and medical-staff control) were compared using one-way ANOVAs on a set of demographic and clinical variables in order to identify group differences that may need to be accounted for in covariate analyses. These variables included age, education, anxiety, depression and pain intensity. Although not included in Table 1, note that mean pain intensity values between in-patient and out-patient chronic pain patients were essentially identical (58.02 and 57.01, respectively). The results of this analysis revealed significant mean differences between the three groups on age, education, pain intensity, anxiety and depression (see Table 1). The following multivariate analyses were carried out to test whether the potential covariates were significantly related to the dependent variables. Pillai's trace was used as the test statistic. A 3 (group) $\times$ 6 (word response) MANCOVA revealed that neither depression ($F(6,167) = .770$, $p > .594$) nor anxiety ($F(6,167) = .483$, $p > .820$) were significantly related to the number of pain and disability association responses. The MANCOVA computed to compare the effects of pain intensity for the acute pain and chronic pain groups indicated that pain intensity was not significantly associated with the number of pain and disability associations ($F(6,121) = .818$, $p > .558$). However, both education ($F(6,167) = 3.917$, $p < .001$) and age ($F(6,167) = 4.317$, $p < .001$) were found to be significantly related to pain and disability homograph responses in the multivariate analysis. Thus, both level of education and age were included as covariates in subsequent analyses.

Homograph response analysis
MANCOVAs that included both age and education as covariates were conducted to test the content specificity of cognitive bias for patients with chronic pain. The independent variable for the following analyses was group (chronic pain, acute pain/post-surgical and medical-staff control), while the dependent variables were type of coded word response. The word responses were computed by summing the number of pain or illness/disability responses to the three types of homographs, i.e. homographs that were judged to be:

(1) related to pain,
(2) related to illness or disability, and
(3) unrelated to pain, illness or disability.

The combination of homographic word type and either the disability or pain response resulted in six categories of reponses: PRPH (pain responses to pain homographs); PRDH (pain responses to disability homographs); PRNH (pain responses to neutral homographs); DRDH (disability responses to disability homographs); DRNH (disability to neutral homographs); or DRPH (disability responses to pain homographs). Significant multivariate *F*s reported are those associated with Pillai's trace. When multivariate

Table 1. Mean values for groups on demographic and clinical variables

	Chronic pain			Acute pain			Medical staff			
	M	SD	95% CI	*M*	SD	95% CI	*M*	SD	95% CI	*F* test
Age	51.22_b	(13.10)	48.28–54.15	60.92_a	(8.96)	38.49–43.93	41.21_c	(9.38)	38.49–43.93	17.66**
Education	5.41_b	(1.36)	5.10–5.73	5.73_b	(1.66)	6.64–6.97	6.80_a	(.54)	6.64–6.97	17.12**
STAI	46.97_a	(14.88)	31.06–36.53	42.98_a	(13.08)	39.18–46.78	33.79_b	(9.42)	31.06–36.53	15.24**
BDI	17.19_a	(10.73)	14.79–19.59	11.90_b	(8.67)	9.38–14.41	5.79_c	(5.47)	4.20–7.38	24.18**
Pain intensity	57.30	(28.08)	51.01–63.59	40.98	(24.85)	33.76–48.20	–	–	–	10.98*

* $p < .01$; ** $p < .001$.
Notes: STAI = State-Trait Anxiety Inventory; BDI = Beck Depression Inventory. Pain intensity analysis was only carried out on chronic and acute pain groups because a rating of 'no pain' was an inclusion criteria for medical-staff controls. The education variable represents mean scores on an education scale mean number of years of education. Means with different subscripts differ significantly by $p < .01$.

analyses were significant, they were followed up with ANCOVAs to test univariate effects and then by the testing of group contrasts.

A MANCOVA comparing the three groups (chronic pain, acute pain and medical-staff control) on the six word response categories (PRPH, PRDH, PRNH, DRDH, DRNH and DRPH) yielded significant results. As shown in Table 2, univariate tests for between-participant effects revealed group differences for PRPH, PRDH, DRDH and DRNH. No differences were found between the groups on PRNH ($p = .20$) or on DRDH ($p = .22$).

Group contrasts were employed to determine specific group $\times$ homographic response differences (see Table 2). The contrasts compared the chronic pain group to both the acute pain and medical-staff control groups. For the PRPH, the chronic pain group produced significantly more pain responses than either the acute pain ($p < .001$) or the medical-staff control ($p < .001$) groups. For the PRDH, the chronic pain group produced significantly more pain responses than the medical-staff control group ($p < .001$), but not the acute pain group ($p < .33$). For the DRDH, the chronic pain group produced more disability responses than the acute pain group ($p < .001$), but not the medical-staff control group ($p < .93$). For the DRNH, the chronic pain group produced more disability responses than the medical-staff control ($p < .001$), but not the acute pain group ($p < .13$).

Discussion

This study was designed to resolve three questions raised by previous interpretation bias studies (Pincus *et al.*, 1994, 1996). First, do the previously reported cognitive bias effects with chronic pain patients depend on whether the homographic stimuli are pain-related, disability-related, or neutral? More specifically, what is the nature of the response bias evidenced by chronic pain samples in previous studies? Second, are the bias effects specific to patients with chronic pain or would such biases be present in any patients that were 'in pain' at the time of study? Finally, are bias effects merely because of a chronic pain patient's high level of exposure to a medical environment?

The current data suggest that the homograph response results differ greatly depending on the type of homographic stimuli presented. Previous pain bias studies (Pincus *et al.*, 1994, 1996) only coded the responses as whether or not they were related to pain, ignoring the possibility of illness/disability responses. Looking at pain responses to pain homographs in the current study, the chronic pain group recorded more pain responses than either the acute pain or medical-staff control groups. On the other hand, none of the groups differed in terms of disability responses to the pain homographs. Further evidence for homographic content specificity was present in the responses to disability homographs. The chronic pain group gave more pain responses to the disability homographs than the medical-staff control group, but not the acute pain group. However, when looking at disability responses to disability homographs, the chronic pain group produced more responses than the acute pain group, but not the medical-staff control group. Clearly, group responses differed depending on the stimuli, and the stimuli that appear to provide the effect that is most specific to chronic pain patients are pain stimuli.

The current data suggest that cognitive interpretation bias effects are specific to long-term effects of chronic pain. This conclusion derives from results comparing homographic responses of acute pain groups to those of the chronic pain group. It was found that the chronic pain group produced more pain responses to pain homographs

Table 2. Education and age adjusted mean values of homographic responses from *post hoc* analysis

	Chronic pain			Acute pain			Medical staff			
	M	SD	95% CI	*M*	SD	95% CI	M	SD	95% CI	F test
PRPH	5.55_a	(3.33)	4.96–6.13	3.31_b	(1.81)	2.52–4.10	2.42_b	(2.16)	1.59–3.25	21.97*
PRDH	1.54_a	(1.17)	1.30–1.78	1.33_a	(1.14)	1.00–1.66	$.66_b$	(.89)	.32–1.01	7.84*
PRNH	$.11_a$	(.54)	.01–.20	$.13_a$	(.25)	.01–.25	$.01_a$	(.15)	.01–.10	1.61, n.s.
DRPH	2.86_a	(1.66)	2.48–3.22	2.78_a	(1.66)	2.29–3.27	2.29_a	(1.44)	1.77–2.81	1.52, n.s.
DRDH	7.12_a	(2.79)	6.45–7.79	3.68_b	(3.11)	2.78–4.59	6.66_a	(2.96)	5.71–7.61	18.09*
DRNH	$.59_a$	(.91)	.44–.74	$.69_a$	(.63)	.49–.89	$.05_b$	(.25)	.00–.26	9.84*

* $p < .001$.
Notes: PRPH = pain responses to pain homograph; PRDH = pain responses to disability homographs; PRNH = pain responses to neutral homographs; DRPH = disability responses to pain homographs; DRDH = disability responses to disability homographs; DRNH = disability responses to responses to neutral homographs. Means with different subscripts differ significantly by $p < .001$.

than the acute pain group. Although the chronic and acute pain groups differed significantly in terms of levels of pain, their mean levels of pain (57.31 and 40.98, respectively) were both in the range of moderate pain (Serlin, Mendoza, Nakamura, Edwards, & Cleeland, 1995). It appears, then, that these cognitive biases may be related to the effects of prolonged pain. Pain, over time, presents the opportunity for the development of additional pain associations. These findings concur with previous studies that found that homographic response biases are related to the frequency or experience with drinking (Earleywine, 1994) and other repetitive behaviours (Stacy, Leigh, & Weingardt, 1997).

The interpretation bias effects of pain responses to pain homographs also do not appear to be owing to the effects of prolonged exposure to a medical environment. This conclusion stems from the comparison of homographic responses of medical-staff control participants to those of chronic pain patients. The similarity in cognitive bias for disability responses to disability homographs for the chronic pain and medical-staff control group may reflect the shared exposure to medical settings found in both groups. However, while the two groups may be equally likely to produce disability homographs, it is not possible to determine what meaning each group may derive from such associations. It may be that such responses are more personally relevant to patients with chronic pain than to the medical staff. Although the current study does include one additional patient sample (the acute pain group), future research might compare the responses of chronic pain patients to that of a pain-free sample of medical patients.

Thus, the results of the current study data offer some answers to the questions related to content specificity of interpretation biases. The homographic response category that appears to be most specific to patients with chronic pain are pain responses to pain homographs. Comparisons between the acute and chronic pain groups suggest that pain bias results are due to the effects of prolonged pain and not to state effects of pain. Comparisons between the chronic pain group to the medical-staff control group suggest that the pain bias effects do not appear to be due to the high rates of medical utilization and prolonged exposure to medical environments (Gatchel & Turk, 1996).

The specificity of the findings related to the chronic pain group's pain responses to pain homographs suggest several directions for future research. Given the consistency of results that support the existence of a homographic response bias in patients with chronic pain, a future direction of this research might involve focusing on what, if any, clinical significance these findings hold. For instance, how do these findings relate to other cognitive variables that have been found to be significant predictors of outcome of pain treatment such as 'catastrophizing' or 'pain as illness' beliefs (Turner, Jensen & Romano, 2000)? Another question that is of interest both to pain practitioners and cognitive scientists is what happens to a pain patient's level of cognitive bias post-treatment and at longer-term follow-up? Similar studies have been conducted by researchers studying cognitive biases in anxiety before and after treatment (Mathews, Mogg, Kentish, & Eysenck, 1995; Mogg, Bradley, Millar, & White, 1995). A pre- to post-treatment test strategy could easily be applied to the homograph response bias paradigm. Changes in a chronic pain patient's level of cognitive bias might be an indication of positive treatment outcome in the same manner that other cognitive bias studies have been in patients with anxiety disorders (Mathews *et al.*, 1995; Mogg *et al.*, 1995). Identification of treatment factors that are related to the changes in response bias might also indicate why some patients form such biases in the first place. From the perspective of cognitive scientists, a change or decrease in such a bias might also provide valuable information. At the time of writing, researchers looking at individual differences in word association have only investigated factors involved in the formation of word associates and have not examined how associations, once formed, might change.

In summary, the current study found convergent data suggesting that pain responses to pain cues represent the associate response bias that is most specific to patients with chronic pain. Furthermore, this bias appears related to long-term effects of being in pain and does not appear related to the effects of extended exposure to medical environments. The conclusions of the current study are limited, however, by the fact that neither this study nor previous studies have tied response bias findings to clinically significant phenomena. Future studies might address this question by focusing on whether degree of response bias interacts with pain treatment outcome or with predictors of pain treatment outcome.

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Appendix

Pain-related words	Disab.-related words	Neutral words
annoy	ace*	act*
back*	activity	affair*
block*	bed	article*
blunt	bend*	ball*
chest*	blood	beam*
cramp	boil	being*
deep*	boil*	bit*
doctor*	carry*	boot*
dull*	cast*	cabinet*
electric*	collect*	call*
fire*	condition*	charm*

Pain-related words	Disab.-related words	Neutral words
head*	die*	class*
ice*	disable*	cloud*
intensity	disorder*	compact*
irritating	dressing	deck*
jam*	exam	dirt*
jar*	gloves	egg*
joint*	graft	entrance*
knifing*	growth*	extra*
knot*	guard*	fawn*
lash*	hamper*	film*
nagging*	invalid*	gag*
pounding*	lie*	harp*
relief*	limp*	juice*
scratch*	nerve*	marble*
sensation	physical*	mold*
sensitive*	rehabilitate	mug*
severe	scalpel	rake*
shooting*	sex*	reflect*
sore*	shot*	round*
splitting	sling*	royal
squeeze*	slipped*	safari
stabbing*	stitch*	stoplight
stiff*	tablet*	strawberry
stinging*	terminal*	structure
stretch*	walker*	underwater
stub*	well*	utensil
tear*	wheel*	washcloth
touchy	wound*	whale
trigger	wrench*	woods

* Denotes homographic stimulus